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Indian Standard
METHODS FOR SAMPLING FERRO-ALLOYS FOR DETERMINATION OF CHEMICAL COMPOSITION
(First Revision)

Second Reprint FEBRUARY 2001

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Gr 4 *December* 1977

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TO

IS:1472-1977 METHODS FOR SAMPLING FERRO-ALLOYS FOR DETERMINATION OF CHEMICAL COMPOSITION

(First Revision)

Sampling of Group III alloys has been elaborated in order to cater to different situations. A few modifications have been made in sample preparation procedures.

(Page 8, clause 5.2.3.2) - Substitute the following for the existing clause:

'5.2.3.2 Gross sample - When the material is supplied in wagons or trucks, the number of sub-lots shall be according to Table 1 and hence the entire consignment shall be divided into suitable number of wagons or trucks constituting sub-lots. Sampling shall be done from each sub-lot preferably when the material is in motion, that is, during loading or unloading. Suitable sample cutter shall be used for collecting material at regular intervals so that the gross sample so collected shall not be less than 100 kg in mass.'

5.2.3.3 Since these alloys are heavy and using a sampling scoop is not practical, the following method may preferably be be used for collection of gross sample:

The material in one out of every five wagons or trucks or payloader buckets shall be opened on clean levelled ground in a single layer. The square frame of size on each side equal to at least three times the largest lump size shall be placed at random at one point on this layer and all those pieces which are completely inside and also which are at least

50 percent inside the frame shall be collected as one increment. From each selected wagons or trucks, at least two increments shall be collected in this fashion. However, the gross sample shall not be less than 100 kg in mass from each sub-lot.

5.2.3.4 When both the above methods are not possible, sampling may be done from stockpiles. For this purpose, trench sampling method may be used. By this method, material in a surface of 30-cm diameter cross section and over entire depth of stockpile shall be collected as one unit sample. If there are a number of stockpiles at least 25 percent of the stockpiles in the sub-lot shall be sampled in this manner ensuring that the minimum gross sample mass is satisfied.

5.2.3.5 Sampling from containers - When the alloys are supplied in containers, the sampling shall be done according to 5.3.3.'

(*Page* 8, *clause* 5.2.5) - Substitute '*Group V and Group VI Alloys*' *for* '*Group VI Alloys*'.

(*Page* 8, *clause* 5.2.5.1, *line* 2) - Substitute '5 000' *for* '10 000'.

(*Page* 9, *clause* 5.3.3.2) - Substitute the following for the existing clause:

'5.3.3.2 Gross sample - One out of every five containers shall be opened and content poured on a levelled ground. A gross sample of mass 100 kg shall be collected by the same procedure as in 5.2.3.2.'

(*Page* 10, *clause* 6.1.3, *third sentence*) - Substitute the following for the existing sentence:

'The 20 kg sample thus obtained shall be reduced by way of coning and quartering to not less than 500 g.

The sample so obtained shall be pulverised to pass through 150-micron sieve totally.'

(Page 11, clause 6.1.4, second sentence) – Substitute the following for the existing sentence:

'All the drillings so obtained are mixed and passed through 500-micron sieve to remove drill bit contamination and then crushed in hardened alloy steel mortar to pass through 150-micron sieve.'

(SMDC 4)

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IS 1472 : 1977 METHODS FOR SAMPLING FERRO-ALLOYS FOR DETERMINATION OF CHEMICAL COMPOSITION

(First Revision)

(*Page* 6, *clause* 5.2) — Substitute the following for the existing:

' **5.2 Sampling of Alloys in Lump Form (for Alloys in the Groups I, II, III, IV, V and VI)**'

(MTD 29)

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Indian Standard

METHODS FOR SAMPLING FERRO-ALLOYS FOR DETERMINATION OF CHEMICAL COMPOSITION

(First Revision)

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Indian Standard

METHODS FOR SAMPLING FERRO-ALLOYS FOR DETERMINATION OF CHEMICAL COMPOSITION

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 22 August 1977, after the draft finalized by the Methods of Sampling Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was originally published in 1959, wherein for the purpose of sampling, ferro-alloys had been divided into three groups. Subsequently in 1962, metallic based ferro-alloys had been added as a fourth group and it was covered under Part II of this standard. With the experience gained over these years, the need for regrouping these alloys, as well as amalgamation of these two parts have arisen. Further, virgin metals that are serving the same purpose as ferro-alloys for steel making, are also covered under a separate group. Accordingly, ferro-alloys are covered under six groups and sampling procedures have been modified wherever necessary and included in this standard.

0.3 In due course, separate sampling standards for each ferro-alloy, based on investigations, will be prepared. Such standards will be prepared to cover size analysis and chemical composition.

0.4 Ferro-alloys are generally supplied in containers and it is often necessary to adopt two stage sampling procedure, that is, random selection of containers in the first stage and sampling of ferro-alloys from the selected containers in the second stage. Thus the desired precision of the estimate obtained from sampling and also the cost involved will be the guideline for deriving an optimum sampling procedure for ferro-alloys. The preparation of representative sample from a consignment of ferro-alloys is a difficult operation since some ferro-alloys are largely heterogeneous. In those cases of heterogeneity arising out of segregation, it is very important that samples are taken from different positions of the container. Sampling procedure as laid down in this standard ensures the desired degree of precision of the estimates taking into account the costs involved.

0.5 For general guidance on the basic principles of sampling from a lot, reference may be made to IS : 1548-1969*.

0.6 In reporting the results of test or analysis, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960†.

1. SCOPE

1.1 This standard lays down the procedure to be followed in collecting and preparing samples representing a lot of ferro-alloys in order to determine the chemical composition of the alloy in the lot.

1.2 For the purpose of this standard ferro-alloys have been divided into the following groups:

Group I

1. Ferrosilicon except FeSi20P15 Grade
2. Silico-chromium
3. Calcium silicon

Group II

1. Spiegeleisen
2. Ferrosilicon FeSi20P15 Grade

Group III

1. Ferromanganese
2. Silicomanganese
3. Ferrochromium (high carbon)
4. Ferrophosphorous

Group IV

1. Ferrochromium (low carbon)

Group V

1. Ferrovanadium
2. Ferrotungsten
3. Ferrotitanium
4. Ferromolybdenum
5. Ferrozirconium
6. Ferroboron
7. Ferroniobium (ferrocolumbium)
8. Ferronickel

---

*Manual on basic principles of lot sampling (*first revision*).
†Rules for rounding off numerical values (*revised*).

Group VI

1. Metallic manganese
2. Metallic silicon
3. Metallic chromium
4. Foundry nickel
5. Misch metal

2. TERMINOLOGY

2.1 Lot — The quantity of ferro-alloys of one type and grade offered for inspection at one time.

2.2 Laboratory Sample — The quantity of alloy obtained by reducing a gross sample following a specified procedure, and sent to the loboratory for testing.

2.3 Sub-lot — The quantity of ferro-alloy in one of the various parts into which the lot is divided for the purpose of sampling.

2.4 Gross Sample — The total sample obtained by combining together all the increments from a sub-lot. There will be as many gross samples as the number of sub-lots.

2.5 Increment — The quantity of ferro-alloy obtained by a sampling device at one time and in one motion from a lot.

3. SAMPLING PROCEDURE

3.1 Ferro-alloys are sampled either in liquid form at the place of manufacture (*see* **4**), or in solid form supplied in bulk (*see* **5.2**), or in crushed form supplied in filled containers (*see* **5.3**). The relevant procedure of sampling for various types of ferro-alloys are considered in detail.

4. SAMPLING IN LIQUID FORM AT THE PLACE OF MANUFACTURE (FOR ALL ALLOYS IN ALL THE GROUPS)

4.1 Sampling of alloys in liquid form at the place of manufacture eliminates a number of difficulties. It is, therefore, recommended that wherever possible the quality of a lot of ferro-alloys should be determined from sample drawn and prepared at the place of manufacture. Samples shall be drawn in accordance with **4.2**.

4.2 Gross Sample — During the tapping of molten alloy, from each cast or heat, three spoonfuls of alloy are collected, avoiding dust and slag. These shall be collected during the beginning, middle and at the end of the tapping period and shall be poured into small moulds separately. The surface of the three castings so obtained shall be cleaned until free from foreign matter and the outer skin removed (by grinding or otherwise). All the three castings are broken together and crushed to 5 mm size and mixed thoroughly to constitute a gross sample weighing 1·5 kg.

4.2.1 The final sample for chemical analysis from the gross sample obtained in **4.2** shall be prepared in accordance with **6**.

5. SAMPLING IN SOLID FORM (FOR ALLOYS IN ALL THE GROUPS)

5.1 Alloys are normally in the lumps or crushed forms. Different procedures are required for sampling the lump and crushed alloys.

5.1.1 Sampling shall be carried out at the time of loading or unloading or during packing or unpacking.

5.2 Sampling of Alloys in Lump Form (for Alloys in the Groups I, II, III, IV and VI)

5.2.1 *Group I Alloys*

5.2.1.1 *Sub-lot* — The consignment shall be first divided into homogeneous lots of not more than 5 000 tonnes in mass. Each lot shall be divided into a suitable number of sub-lots of approximately equal mass according to Table 1. If a lot is continuously unloaded, the sub-lot shall be formed by fixing equal intervals of unloading so that the ferro-alloys unloaded in an interval shall form a sub-lot for the purpose of sampling.

TABLE 1 MINIMUM NUMBER OF SUB-LOTS INTO WHICH A LOT IS TO BE DIVIDED

(*Clauses* 5.2.1.1, 5.2.2.1, 5.2.3.1, 5.2.4.2, 5.2.5.1, 5.3.2.1, 5.3.3.1 *and* 5.3.5.1)

MASS OF THE LOT (1)	MINIMUM NUMBER OF SUB-LOTS (2)
tonnes	
Up to 25	1
26 ,, 100	2
101 ,, 300	3
301 ,, 800	4
801 ,, 1 500	5
1 501 ,, 3 000	8
3 001 and above	10

5.2.1.2 *Gross sample* — From each sub-lot a gross sample consisting of prescribed number of increments shall be drawn and kept separately. Thus there will be as many gross samples as the number of sub-lots into which a lot has been divided.

5.2.1.3 The number of increments to be taken from a sub-lot shall be governed by the mass of the increments as specified in Table 2. The increments shall be drawn with the help of a suitable sampling scoop.

TABLE 2 MINIMUM MASS OF THE GROSS SAMPLE AND MINIMUM NUMBER OF INCREMENTS LUMP FORM (GROUP I ALLOYS)

Mass of gross sample, in kg, *Min*	125
Mass of increment, in kg, *Min*	5
Number of increments	25

5.2.2 *Group II Alloys*

5.2.2.1 *Sub-lots* — The consignment shall be first divided into homogeneous lots of not more than 10 000 tonnes in mass. Each lot shall be divided into a suitable number of sub-lots, approximately equal mass according to Table 1. If a lot is continuously unloaded, the sub-lot shall be formed by fixing equal intervals of unloading so that the ferro-alloys unloaded in an interval shall form a sub-lot for the purpose of sampling.

5.2.2.2 *Gross sample* — The material shall be collected by selecting pigs or pieces at random at regular intervals during the loading or unloading. There will be as many gross samples as there are number of sub-lots.

5.2.2.3 The minimum number of pigs or pieces to be selected shall be according to Table 3.

TABLE 3 MINIMUM NUMBER OF PIGS OR PIECES TO BE SELECTED FROM EACH SUB-LOT

MASS OF THE SUB-LOT (1)	MINIMUM NUMBER OF PIGS OR PIECES (2)
tonnes	
Up to 50	10
51 ,, 100	20
101 ,, 300	30
301 ,, 500	40
501 and above	50

5.2.3 *Group III Alloys*

5.2.3.1 *Sub-lots* — The consignment shall be divided into homogeneous lots of not more than 5 000 tonnes in mass. Each lot shall be divided into a suitable number of sub-lots approximately of equal mass according to Table 1.

5.2.3.2 *Gross sample* — For each sub-lot, a gross sample shall be collected throughout the period of loading or unloading by taking increments of 5 kg at regular intervals. The gross sample collected in this way shall not be less than 100 kg in mass. Suitable sampling scoop shall be used for this purpose.

5.2.4 *Group IV Alloy*

5.2.4.1 The combination of hardness and toughness characteristics of this material makes it the most difficult of any of the ferro-alloys to be sampled properly.

5.2.4.2 *Sub-lot* — Each consignment shall be divided into homogeneous lots of not more than 5 000 tonnes in mass. Each lot shall be divided into a suitable number of sub-lots of approximately of equal mass according to Table 1.

5.2.4.3 *Gross sample* — From each sub-lot at least 200 kg of the material shall be collected to constitute a gross sample. From each sub-lot suitable number of casts are drawn at random throughout the sub-lot. Piece or pieces representing a full cross section of the original cast shall be taken. The piece(s) shall be uniform in size as far as possible.

5.2.5 *Group VI Alloys*

5.2.5.1 *Sub-lot* — The consignment shall be first divided into homogeneous lots of not more than 10 000 tonnes in mass. Each lot shall be divided into a suitable number of sub-lots of approximately equal mass according to Table 1. If a lot is continuously unloaded, the sub-lot shall be formed by fixing equal intervals of unloading so that the material unloaded in an interval forms a sub-lot for the purpose of sampling.

5.2.5.2 *Gross sample* — From each sub-lot a gross sample consisting of prescribed number of increments shall be drawn and kept separately. Thus there will be as many gross samples as the number of sub-lots into which a lot has been divided.

5.2.5.3 The number of increments to be taken from a sub-lot shall be as specified in Table 4. The location of an equal number of points for collecting these increments shall be evenly distributed over the surface of the sub-lot. In case it is difficult to break the lump, drillings or sawings may be taken.

TABLE 4 MINIMUM MASS OF THE GROSS SAMPLE AND MINIMUM NUMBER OF INCREMENTS

Mass of the gross sample, in kg, *Min*	1
Mass of increments, in kg, *Min*	0·1
Number of increments	10

5.3 Sampling of Alloys in Crushed Form (for All Alloys in the Groups I, III, IV, V and VI)

5.3.1 Group V alloys are transacted in crushed form packed in containers. Other alloys in the groups I, III, IV and VI are also crushed and packed in containers, besides being supplied in lump form (*see* **5.2**).

5.3.2 *Group I Alloys*

5.3.2.1 *Sub-lot* — The alloys supplied in containers shall be divided into suitable number of sub-lots according to Table 1. At least 20 percent of the containers shall be selected at random. From each selected containers at least one increment of 2 kg shall be taken so as to give the gross sample mass as specified in Table 5.

TABLE 5 MINIMUM MASS OF THE GROSS SAMPLE AND MINIMUM NUMBER OF INCREMENTS (CRUSHED ALLOYS)

Mass of gross sample, in kg, *Min*	50
Mass of increments, in kg, *Min*	2
Number of increments	25

In case the number of containers to be opened is less than 25, adequate number of increments shall be taken to give the minimum number of increments specified in Table 5.

5.3.2.2 *Gross sample* — The increments as obtained in **5.3.2.1** shall be mixed thoroughly to form a gross sample.

5.3.3 *Group III and IV Alloys*

5.3.3.1 *Sub-lot* — The alloys supplied in containers shall be divided into suitable number of sub-lots according to Table 1.

5.3.3.2 *Gross sample* — One out of every five containers shall be opened and 2 kg of material shall be taken from each selected container so as to give a gross sample of size 100 kg.

5.3.4 *Group V Alloys*

5.3.4.1 *Sub-lot* — Each lot shall be divided into homogeneous sub-lot of not more than 2·5 tonnes each.

5.3.4.2 *Gross sample* — At least 25 percent of the containers shall be opened and adequate amount of sample shall be collected to carry out chemical tests.

5.3.5 *Group VI Alloys*

5.3.5.1 *Sub-lot* — The crushed alloy supplied in containers in each lot shall be divided into a suitable number of sub-lots, of approximately equal mass, in accordance with Table 1.

5.3.5.2 *Gross sample* — At least 5 percent of the containers shall be selected at random. From each of the containers so selected, proportionate quantities of chippings or drillings or sawings, weighing about 0·1 kg, shall be collected from different parts of the container. The minimum number of containers to be opened in a sub-lot shall be 10.

6. REDUCTION OF GROSS SAMPLE

6.1 Preparation of Sample for Chemical Analysis — Alloys in each gross sample shall be crushed and reduced for chemical analysis. Crushing and reduction of alloys vary from group to group.

6.1.1 *Group I Alloys* — The gross sample collected according to **4.2** or **5.2.1.2** or **5.3.2.2** shall be crushed by a suitable jaw crusher or roll crusher. This crushed material shall be reduced by adopting one of the methods of reduction detailed in **6.1.7** to **6.1.9**. The material shall pass through various sieves from 10 mm down till 150-micron sieve. Sieving shall be done till 100 g of the final sample obtained, passes through 150-micron sieve. The final laboratory sample shall be prepared as detailed in **6.1.10**.

6.1.2 *Group II Alloys* — Each pig in the gross sample, collected according to **4.2** or **5.2.2.2**, shall be divided into two parts by any convenient means and one half of each pig shall be kept separately. From the fractured surface of each of these half pigs, approximately equal portion shall be taken by any suitable means (as by spalling with a heavy hammer). Care shall be taken by the sampler to see these spalls are not all from the outer edges of the pig but at least some are obtained from the central portion and that none contains portions from the outer surface which may be contaminated with sand or other foreign material. The spalling from each pig so collected shall be approximately of same mass.

6.1.2.1 The portions shall then be combined to form a sample and crushed (preferably in a hardened alloy steel mortar) and sieved until it passes through 500-microns sieve. From this about 500 g shall be separated by adopting any one of the methods of reduction given in **6.1.7** to **6.1.9**. The final laboratory sample shall be prepared as detailed in **6.1.10**.

6.1.3 *Group III Alloys* — The gross sample collected according to **4.2** or **5.2.3.2** or **5.3.3.2** shall be reduced by adopting any one of the methods detailed in **6.1.7** to **6.1.9**. The gross sample shall be crushed to pass through 5-mm sieve and reduced to obtain not less than 20 kg sample. The 20 kg sample shall be pulverised to pass through 150-micron sieve, till 300 g of the final sample is obtained. The pulverizing is best done with hardened alloy steel mortar and pestle. Sieving is best done to keep the size close to 150-micron and prevent loss of dust. The final laboratory sample shall be prepared as detailed in **6.1.10**.

6.1.4 *Group IV Alloys* — Each of the castings in the gross sample collected according to **4.2** or **5.2.4.3** is drilled at various points to a depth of at least 25 mm using the high speed drill bit. All the drillings so obtained are mixed and crushed in hardened alloy steel mortar to pass through preferably 500-micron sieve. The pulverised sample shall be mixed thoroughly and reduced to 300 g of material by adopting any one of the methods detailed in **6.1.7** to **6.1.9**. The final laboratory sample shall be prepared as detailed in **6.1.10**.

6.1.4.1 In the case of crushed alloy, the gross sample collected according to **5.3.3.2** shall be crushed and reduced by any one of the methods detailed in **6.1.7** to **6.1.9** till about 1 kg of sample passes through 1-mm sieve. This is pounded in hardened alloy steel mortar to pass through 500-micron sieve and reduced to a mass of 300 g. The final laboratory sample shall be prepared as detailed in **6.1.10**.

6.1.4.2 Contamination of sample with fragments of steel from the tools used in preparing the sample should be avoided. The pulverizing sieve, which is exclusively used for this group of alloy, should be thoroughly cleaned before use so that there is no possibility for any contamination during sampling.

6.1.5 *Group V Alloys* — The gross sample, collected according to **4.2** or **5.3.4.2** shall be crushed and reduced by any one of the methods detailed in **6.1.7** to **6.1.9**. The material is crushed to 6 mm and mixed, reduced and ground to pass through 250-micron sieve. The final laboratory sample shall be prepared as detailed in **6.1.11**.

6.1.6 *Group VI Alloys* — The gross sample, collected according to **4.2**, or **5.2.5.2**, or **5.3.5.2** shall be crushed and reduced by stages by any one of the methods given in **6.1.7** to **6.1.9**. The pulverised material is finally made to pass through 150-micron sieve. The final laboratory sample shall be prepared as detailed in **6.1.10**.

6.1.7 *Reduction by Riffle Divider* — After each crushing, the alloy shall be mixed and poured into the riffle. This process shall be repeated using riffles of different sizes according to the size of the crushed alloy.

6.1.8 *Coning and Quartering Method* — In this method, the crushed alloy shall be well-mixed and then scooped into a cone-shaped pile. Care shall be taken to drop each scoopful over the same spot to ensure even distribution on all sides on the cone.

After the cone is formed, it shall be flattened by pressing the top of the cone with the smooth surface of the scoop. Then it is cut into quarters by two lines which intersect at right angle at the centre of the base of the cone. The bulk of the sample is reduced by half by rejecting any two diagonally opposite quarters.

6.1.9 *Increment Division Method* — When the alloys have been crushed to a sufficiently small particle size, this method may be applied satisfactorily.

6.1.9.1 *Procedure* — The division of the gross sample by the manual increment division method (*see* Fig. 1) shall be carried out according to the following procedures:

a) Spread the crushed sample on a smooth and flat plate (non-moisture absorbing) into a uniform flat rectangle.
b) Divide the rectangle in five equal parts lengthwise and four equal parts breadthwise.
c) From each of the 20 parts so obtained, equal quantities of sample shall be collected with the help of a suitable scoop and combined together to form the reduced sample.

In the above procedure the scoop shall be inserted to the bottom of the sample layer and if necessary a bumper plate may be inserted in front of the scoop to facilitate the operation.

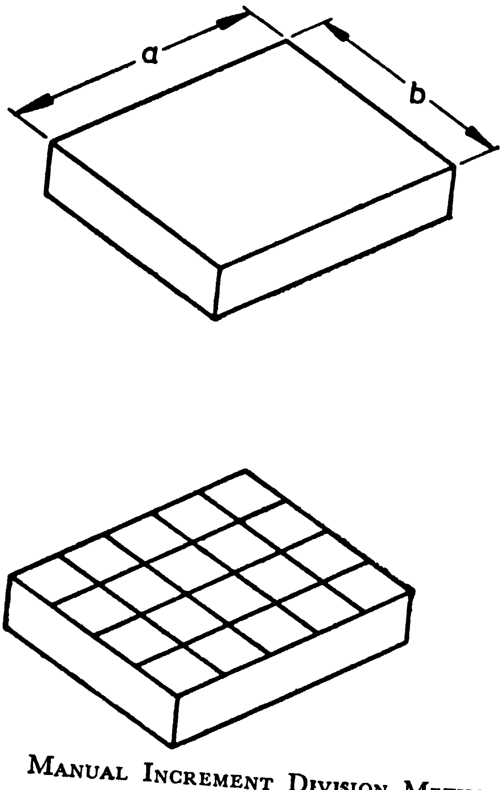

Fig. 1 Manual Increment Division Method

6.1.10 *Alloys in all the Groups Except Group V* — The pulverised material as obtained in **6.1.1**, **6.1.2.1**, **6.1.3**, **6.1.4**, **6.1.4.1** and **6.1.6** shall be poured on glazed paper and mixed thoroughly. The material shall be divided into three portions, one shall be given to the buyer, one for the seller and third to be kept as a referee sample.

6.1.11 *Group V Alloys* — The pulverized material as obtained in **6.1.5** shall be dried at 105°C to 110°C for one hour and put in bottles that can be divided into three groups. One shall be for the buyer, the other for the seller and the third to be kept as a referee sample.

7. NUMBER OF TESTS

7.1 Chemical Analysis — The number of gross samples taken from a lot shall be according to **5**. Each gross sample shall be subjected to a sample preparation to obtain a laboratory sample sufficient to conduct all the chemical determinations. All the laboratory samples shall be tested individually for important characteristics. For the remaining characteristics a composite sample shall be prepared by mixing equal or proportionate quantity of ferro-alloy from each of the laboratory samples, and analyzed. The elements which require individual analysis and those which need only composite sample analysis are listed in Table 6 for each ferro-alloy.

TABLE 6 NUMBER OF TESTS

GROUP	*FERRO-ALLOYS	ELEMENTS IN THE ALLOYS	
		For Which Laboratory Samples Are Analyzed Individually	For which a Composite Sample is Analyzed
(1)	(2)	(3)	(4)
I	Ferrosilicon all grades except FeSi20P15	Silicon Carbon	Sulphur Phosphorus Aluminium
	Silico-chromium	Silicon Chromium Carbon	Aluminium Phosphorus Sulphur
	Calcium silicon	Carbon Calcium Silicon	Manganese
II	Spiegeleisen	Manganese Carbon Phosphorus	Silicon Sulphur
	Ferrosilicon FeSi20P15 Grade	Silicon Carbon	Sulphur Phosphorus Aluminium

*For the chemical composition of the various grades of alloys, reference should be made to the respective Indian Standard specifications.

(*Continued*)

TABLE 6 NUMBER OF TESTS — *Contd*

GROUP	*FERRO-ALLOYS	ELEMENTS IN THE ALLOYS	
		For Which Laboratory Samples Are Analyzed Individually	For Which a Composite Sample is Analyzed
(1)	(2)	(3)	(4)
III	Ferro manganese	Manganese Carbon Phosphorus	Silicon Sulphur
	Silicomanganese	Silicon Manganese Carbon	Sulphur Phosphorus Arsenic
	Ferrochromium (high carbon)	Chromium Carbon	Phosphorus Silicon Sulphur
	Ferrophosphorus	Phosphorus Carbon	
IV	Ferrochromium (low carbon)	Chromium Carbon	Phosphorus Silicon Sulphur
V	Ferrovanadium	Vanadium Carbon Silicon	Sulphur Phosphorus Aluminium
	Ferrotungsten	Tungsten Carbon Manganese	Aluminium Silicon Phosphorus Sulphur Tin Arsenic Antimony
	Ferrotitanium	Titanium Carbon Aluminium Silicon	Sulphur Phosphorus
	Ferromolybdenum	Molybdenum Carbon	Silicon Sulphur Phosphorus Copper Aluminium
	Ferrozirconium	Zirconium Silicon	Aluminium Carbon Iron
	Ferroboron	Boron Carbon	Silicon Sulphur Aluminium

*For the chemical composition of the various grades of alloys, reference should be made to the respective Indian Standard specifications.

(*Continued*)

TABLE 6 NUMBER OF TESTS — *Contd*

GROUP	*FERRO-ALLOYS	ELEMENTS IN THE ALLOYS	
		For Which Laboratory Samples Are Analyzed Individually	For Which a Composite Sample is Analyzed
(1)	(2)	(3)	(4)
	Ferroniobium (ferrocolumbium)	Niobium Columbium	Carbon Silicon Titanium Manganese Aluminium Phosphorus Tantalum Iron Sulphur
	Ferronickel	Carbon Nickel	Silicon Manganese Phosphorus Sulphur Chromium Copper
VI	Metallic manganese	Manganese Carbon Phosphorus	Iron Silicon Hydrogen Aluminium Sulphur Heavy metals Nitrogen
	Metallic silicon	Silicon Carbon	Aluminium Iron Calcium Sulphur Phosphorus
	Metallic chromium	Chromium Carbon Silicon	Aluminium Iron Phosphorus Sulphur
	Foundry nickel	Nickel Silicon	Iron Sulphur Cobalt
	Misch metal	Cerium Lanthanum Total Rare-earth Metals Iron	Aluminium Magnesium Calcium Carbon Silicon

*For the chemical composition of the various grades of alloys, reference should be made to the respective Indian Standard specifications.

8. REPORTING OF TEST RESULTS

8.1 Chemical Analysis

8.1.1 For those characteristics where composite samples have been tested, only one test result is available and that result shall be reported as the value of that characteristic for the lot sampled.

8.1.2 When only two laboratory samples have been analyzed individually from a lot, the average of the two available test results shall be reported as the value of the characteristic for the lot sampled. The individual test results shall also be reported to give an indication of the range of variation in quality.

8.1.3 When three or more laboratory samples have been analyzed individually from a lot the following procedure shall be followed to assess the average quality and its limits of variation.

Let x_1, x_2, ...x_n be the results of analyzing 'n' laboratory samples for a particular characteristic

Calculate

$$\text{Average } (\bar{x}) = \frac{x_1 + x_2 + \qquad + x_n}{n}$$

and Range (R) = the difference between the maximum and minimum values.

The limits of variation in the average level of the characteristic in the lot which shall be reported as ($\bar{x} \pm hR$) where h is a factor, the value of which depends upon the number of laboratory samples analyzed. The appropriate value of the factor 'h' is given below:

Number of Laboratory Samples Analyzed	*Value of Factor 'h'*
3	1·30
4	0·72
5	0·51
8	0·29
10	0·23

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